(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 April 2004 (15.04.2004)

PCT

(10) International Publication Number
WO 2004/031946 A1

(51) International Patent Classification[7]: G06F 9/44

(21) International Application Number:
PCT/EP2003/010442

(22) International Filing Date:
18 September 2003 (18.09.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
02022042.2 1 October 2002 (01.10.2002) EP

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: XML INTERFACES IN UNIFIED RENDERING

(57) Abstract: Computer implemented method for validation of computer code, comprising providing a computer program by defining a set of definition instructions, a set of implementation instructions and a script code section, validating the defined sets using a validation tool, validating the script code section using the set of implementation instructions, wherein the definition instructions are classes and the implementation instructions are interfaces, wherein the definition instructions are converted into classes and the implementation instructions are converted into interfaces, wherein the definition instructions and said implementation instructions are described in XML.

WO 2004/031946 A1

XML interfaces in unified rendering

The invention relates in general to programmable electronic multipurpose computers.

Scripting languages, such as JavaScript and Perl, can be used to program applications to be run on computer systems. Correctness of the programmed scripting code is desirable, as with any computer programming in general. A program can be checked or validated prior to use to reduce errors occurring during runtime of the code. It is an object of the invention to reduce the number of errors in computer code. Therefore, the invention provides for a computer implemented method for validation of computer code according to claim 1. By validating both sets of instructions with the script code used, the number of errors will be reduced.

Objects, aspects and advantages of the invention will be better understood from the following detailed description of a preferred embodiment of the invention.

A computer program can be defined in design documentation and specifications. From this starting point an actual implementation can be coded using a suitable programming language.

According to the invention the coding is done using a two-component interface-classes model, and a script coded section. Non-limiting examples of such programming languages are compiler languages and object oriented programming languages. In compiler languages, such as for example Modula-2, these components are implemented as definition modules and implementation modules. In object oriented programming languages, such as for example Java, C++, C#, and Modula-3, the

components are implemented as interfaces and classes, wherein interfaces are equivalent to definition modules and classes are equivalent to implementation modules. The script-coded section can be programmed using any suitable script language, such as for example JavaScript and Perl.

Interfaces in object-oriented programming are used for several purposes. To function for example as a record of promises (with respect to functionality) given by one ("provider") class. This fact is used to verify automatically during compilation whether a second "customer" object is relying on features of a class that have not been promised. Also the interface is used to verify whether the actual implementation of the provider class keeps all its promises.

This allows inspection of the code during compilation and to test or validate whether errors with respect to these fundamentals would occur during runtime. For example methods that are offered by the object can be checked, as well as compliance of object classes with the respective interfaces. If errors are found these can be reported during compilation, so that the errors in the source code can be corrected. Thus runtime errors are reduced in the compiled code.

For example, if an interface promises the availability of a certain method but the method is not present in the implementation, a "customer" of that method would fail at latest at run time. Interfaces enable modern compiler languages to verify the availability of the method during compilation, eliminating this failure mode with the associated debugging effort.

Another example is that can be checked whether a method of an object is called in the code that is not present

in the interface. This would lead in the compiled code during runtime to errors. By checking the interface, this can be caught at the outset, eliminating this failure mode during runtime.

In one embodiment of the invention, a program is programmed in object oriented style using two separate tree structures, written in XML, wherein the first tree structure represents the classes to be implemented and the second tree structure represents the associated interfaces. Note that the invention is not limited to the implementation shown in this example, and that any programming implementation yielding a set of classes/definitions and interfaces/implementations can be employed. Based on this tree structures in XML executable programs can be generated, for example using Extensible Stylesheet Language (XSL) or Apache Velocity. XSL defines the code using two parts; a language for transforming XML documents, and an XML vocabulary for specifying formatting semantics. An XSL style sheet specifies the presentation of a class of XML documents by describing how an instance of the class is transformed into an XML document that uses the formatting vocabulary. On the XML level a syntax check is performed between the interface description and the implementation class description.

Using this method executable programs can be generated for different platforms, for example ABAP, .Net and JavaScript. In case the executable code generated does implement classes and interfaces, such as is the case with ABAP and .Net, the validity of that code can be verified with a compiler program that performs the usage and implementation checks at the semantics level. Then executable program code is generated from the interface description and from the implementation class

description. The thus generated code can then use or call the script coded section when needed.

In this example, the generation of executable programs in script languages, such as for example JavaScript is done by first generating an intermediate code, using a language that supports classes and interfaces. In this example, the intermediate code used can be Java, with implementation for interfaces and classes. The validity of these interfaces and classes is then proved using methods as described above, i.e. using a compiler that performs the usage and implementation checks at the semantics level. This can be done for example by comparing the resulting interfaces with the classes obtained. A successful validation of the Java code means that the original XML code is correct for at least the interface and classes definition. Further the script code section is checked by running it trough an interpreter. This can be for example a JavaScript interpreter if the script code is written in JavaScript. Such interpreters or parsers are known per se in the art. The interpreter yields at least a symbol table including various elements, such as for example variables, used by the script code. The information included in the symbol table is compared to the original XML implementation description. From this comparison can be derived whether the script code is compatible with the implementation description. If the script code is validated accordingly, executable code generated from the sets of definition and implementation instructions, is validated for use with the script code. Thus validated, the number of runtime errors is reduced.

In a further embodiment of the invention, two separate tree structures are provided for, together with a script code section. The first tree structure describes

interfaces, while the second tree structure describes content in the form of classes for a HTML document. The script code section provides functionality for the HTML document, such as for example scrolling of text. The tree structures can be programmed for example in XML, and the script code section can be programmed in JavaScript.

The invention further relates to a program storage device readable by a computer system, embodying a program of instructions executable by the computer system to perform any method according to the invention. As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within the metes and bounds of the claims, or equivalence of such metes and bounds thereof are therefore intended to be embraced by the claims.

Claims

1. Computer implemented method for validation of computer code, comprising
providing a computer program by defining at least one set of definition instructions, at least one set of implementation instructions and at least a script code section,
validating said defined sets using a validation tool, and
validating said script code section using said set of implementation instructions.

2. Method according to claim 1, wherein the definition instructions are classes and the implementation instructions are interfaces.

3. Method according to claim 1, wherein the definition instructions are converted into classes and the implementation instructions are converted into interfaces.

4. Method according to claim 3, wherein said definition instructions and said implementation instructions are described in XML.

5. Method according to claim 4, wherein said classes and interfaces are defined in Java language.

6. Method according to any of the preceding claims, wherein at least one of said sets of instructions is defined in a tree structure.

7. Method according to any of the preceding claims, wherein said script code section is JavaScript.

8. Method according to any of the preceding claims, wherein validating said script code section comprises generating a symbol table by executing said code section in an interpreter, and comparing said symbol table with the implementation instructions.

9. A program storage device readable by a computer system, embodying a program of instructions executable by the computer system to perform a method according to any of claims 1-8.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 03/10442

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F9/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	POLL E ET AL: "Formal specification of the JavaCard API in JML: the APDU class" COMPUTER NETWORKS, ELSEVIER SCIENCE PUBLISHERS B.V., AMSTERDAM, NL, vol. 36, no. 4, 16 July 2001 (2001-07-16), pages 407-421, XP004304906 ISSN: 1389-1286 paragraphs '0001!-'0004!,'0006! -/--	1-7

[X] Further documents are listed in the continuation of box C.

[ ] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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Date of the actual completion of the international search	Date of mailing of the international search report
19 March 2004	29/03/2004

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	FRIEDMAN-HILL E J: "Software verification and functional testing with XML documentation" PROCEEDINGS OF THE 34TH ANNUAL HAWAII INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES, HICSS-34, January 2002 (2002-01), XP002234270 Maui, HI, USA abstract paragraphs '0002!,'0004! ---	1-7
A	FREUND S N ET AL: "A FORMAL FRAMEWORK FOR THE JAVA BYTECODE LANGUAGE AND VERIFIER" ACM SIGPLAN NOTICES, ASSOCIATION FOR COMPUTING MACHINERY, NEW YORK, US, vol. 34, no. 10, October 1999 (1999-10), pages 147-166, XP001148316 ISSN: 0362-1340 paragraphs '0001!,'0002! ---	1-7
A	PAINCHAUD F ET AL: "On the implementation of a stand-alone Javabytecode verifier" ENABLING TECHNOLOGIES: INFRASTRUCTURE FOR COLLABORATIVE ENTERPRISES, 2000. (WET ICE 2000). PROEEDINGS. IEEE 9TH INTERNATIONAL WORKSHOPS ON GAITHERSBURG, MD, USA 14-16 JUNE 2000, LOS ALAMITOS, CA, USA,IEEE COMPUT. SOC, US, 14 June 2000 (2000-06-14), pages 189-194, XP010522934 ISBN: 0-7695-0798-0 -----	